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Influence of Early Acetabuloplasty on the Development of the Acetabulum*

by

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Shelf operation of the acetabulum was first described by KÖNIG in 1891. Thereafter, many modified techniques such as SPITZY and LANCE procedure have been reported, and it has long been believed that the shelf operation plays an important role in the prevention of the development of osteoarthritis in dysplastic hips. The case illustrated in Figures 1-A through 1-D received a shelf operation at five years of age. In this case the development of osteoarthritis seems to have been prevented by the surgery so far as seen at seven years postoperatively.

However, when shelf operations are performed in the early childhood, their long-term results are not always satisfactory. The case illustrated in Figures 2-A through 2-D, for example, received a shelf operation at three years of age and it's immediate postoperative result was considered to be satisfactory. Nevertheless, the result obtained at nine years after surgery is not satisfactory mainly due to insufficient growth of the acetabular roof in the postoperative course. The purpose of the present study is to observe the influence of early acetabuloplasty on the development of the acetabulum and to analyze the reasons why direct surgical involvement to the acetabular roof often interferes with it's growth.

Materials

Materials are fifty-five cases of actabular dysplasia due to congenital dislocation of the hip (Table I.). Among these, forty-three cases received a shelf operation and twelve received

Table I. Materials

	number of cases	age at operation		follow up period
		1-3 years	3-6 years	
shelf operation	43	15	28	5-15 years (average 11 years)
innominate osteotomy	12	8	4	5-8 years (average 6 years)
total	55	23	32	average 10 years

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Key Words : Acetabuloplasty, Shelf operation, Congenital hip dislocation, Development of acetabulum

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an innominate bone osteotomy at the ages less than six years. The follow up period ranges from five to fifteen years … an average of ten years. The procedure employed for the shelf operation was a modification of SPITZY's method (Figs. 3-A and 3-B). Flaps of the cartilaginous acetabular roof were turned down to cover the femoral head and a bone graft taken from the iliac crest was wedged into a groove made between the bony roof and the cartilaginous roof to construct a bone shelf. For the innominate bone osteotomy SALTER's procedure was employed.

Results

When a long-term follow up is made, the bone shelf is observed in some instances to have completely melted away in the early postoperative stage as illustrated in Figures 4-A through 4-D. In the majority of the cases the bone shelf has partially been absorbed within a few years after surgery. Among them, some cases reveal a good radiological appearance (Figs. 1-A through 1-D and 5-A through 5-D), but others reveal an insufficient coverage of the femoral head (Figs. 2-A through 2-D, 8-A through 8-F and 9-A through 9-F). In a few cases the bone shelf is considered to have grown during the postoperative course as illustrated in Figures 6-A through 6-D. Excessive growth of the bone shelf sometimes causes limitation of abduction of the hip joint.

The fate of the bone shelf observed at the latest survey is summarized in Table II. Complete absorption of the bone shelf is observed in 19 per cent, partial absorption in 70 per cent and growth in 11 per cent. The CE angles above 20 degrees are observed in 44 per cent. In other words, the shelf operations are considered to be successful so far only in 44 per cent and 56 per cent of the cases are unsatisfactory in the long-term results.

On the contrary, the innominate bone osteotomy seems to have promoted the development of the acetabulum in the majority of the cases even if the operation was performed in the

1-A 1-B 1-C 1-D

Fig. 1-A Preoperative roentgenogram
Fig. 1-B Shelf operation at five years of age
Fig. 1-C Two years after shelf operation
Fig. 1-D Seven years after shelf operation · satisfactory results

Table II. Fate of Shelf

	number of cases	CE angle	
		above 20°	below 20°
complete absorption	8(19%)	0	8
partial absorption	30(70%)	14	16
growth	5(11%)	5	0
total	43	19(44%)	24(56%)

2-A 2-B 2-C 2-D

Fig. 2-A Shelf operation at three years of age
Fig. 2-B Five months after operation
Fig. 2-C Three years after operation
Fig. 2-D Nine years after operation not satisfactory

early childhood. The cases illustrated in Figures 10-A through 10-C and 11-A through 11-C received an innominate bone osteotomy at the ages between two and five. The development of the acetabulum seems accelerated after surgery resulting in a continuous improvement of the acetabular angle in any hips operated. In Fig 13 are shown the preoperative and postoperative acetabular angles of the twelve cases which received an innominate bone osteotomy. A continuous improvement of the acetabular angle is observed during the postoperative course in all but two cases.

The case illustrated in Figures 12-A through 12-E received an innominate bone osteotomy at two years and five months of age. There is a tendency of the CE angle to increase steadily after surgery until it reaches to the normal. Evaluated by the CE angle which are measured at the latest survey, the innominate bone osteotomy is considered to be successful so far in 83 per cent as shown in Table III.

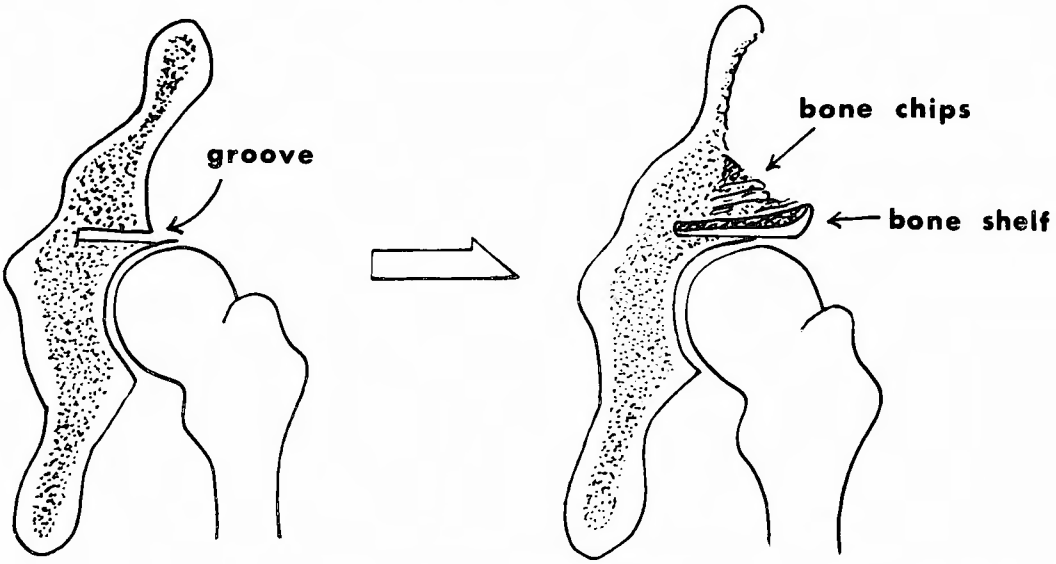


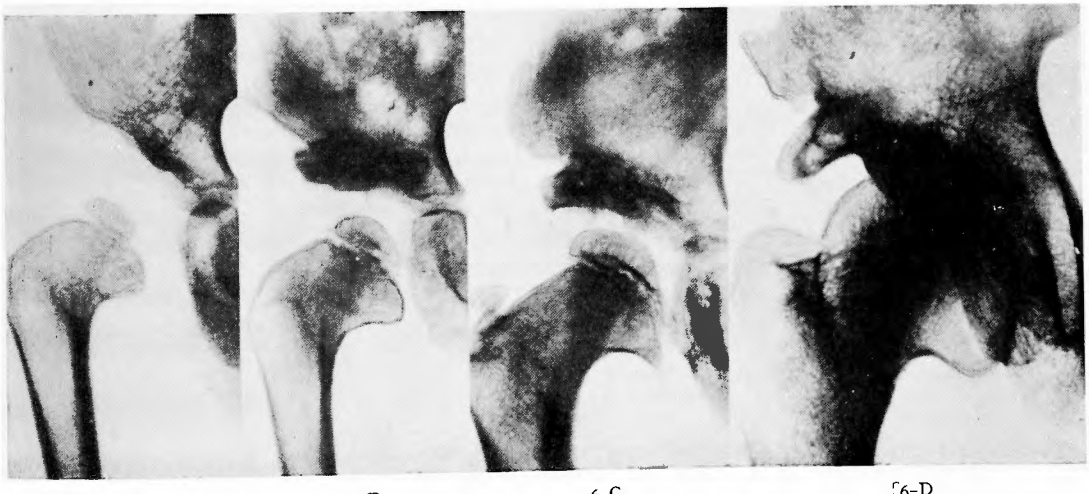
Fig. 3 Procedure of Shelf Operation Employed

4-A 4-B 4-C 4-D

Fig. 4-A Preoperative roentgenogram
Fig. 4-B Shelf operation combined with derotation osteotomy of the femur at two years and five months of age
Fig. 4-C Nine months after operation · early absorption of the shelf
Fig. 4-D Two years after operation not satisfactory

5-A 5-B 5-C 5-D

Fig. 5-A Shelf operation at four years of age
Fig. 5-B One year after operation
Fig. 5-C Three years after operation
Fig. 5-C Ten years after operarion ·· satisfactory results

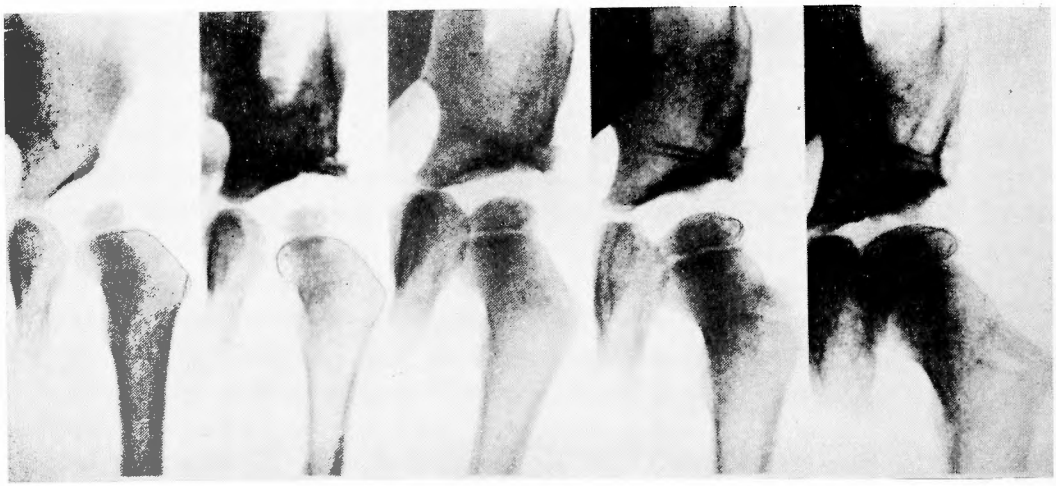


6-A 6-B 6-C 6-D

Fig. 6-A Preoperative roentgenogram
Fig. 6-B Shelf operation at five years of age
Fig. 6-C Two years after operation
Fig. 6-D Ten years after operation ··· excessive growth of the bone shelf with limitation of abduction of the hip joint

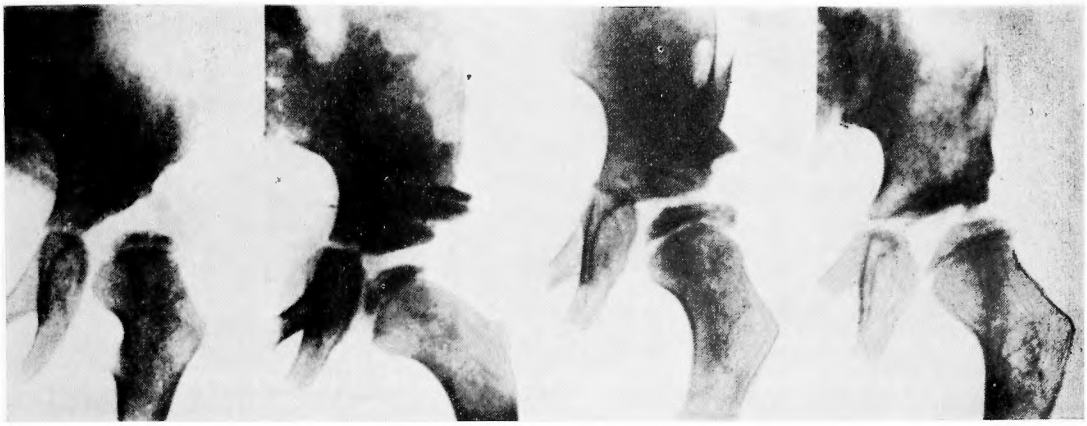
Table III. CE Angle (innominate bone osteotomy)

	number of cases
above 20°	10 (83%)
below 20°	2 (17%)
total	12



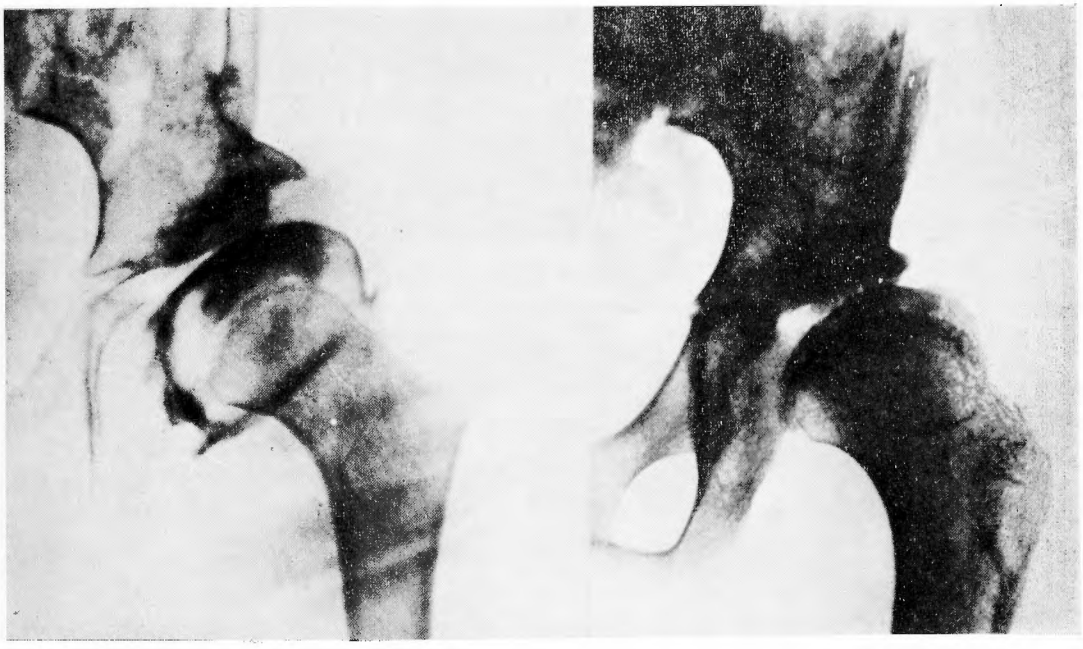
7-A 7-B 7-C 7-D 7-E

Fig. 7-A Preoperative roentgenogram
Fig. 7-B Shelf operation at one year and four months of age
Fig. 7-C One year after operation
Fig. 7-D Three years after operation
Fig. 7-E Five years after operation



8-A 8-B 8-C 8-D

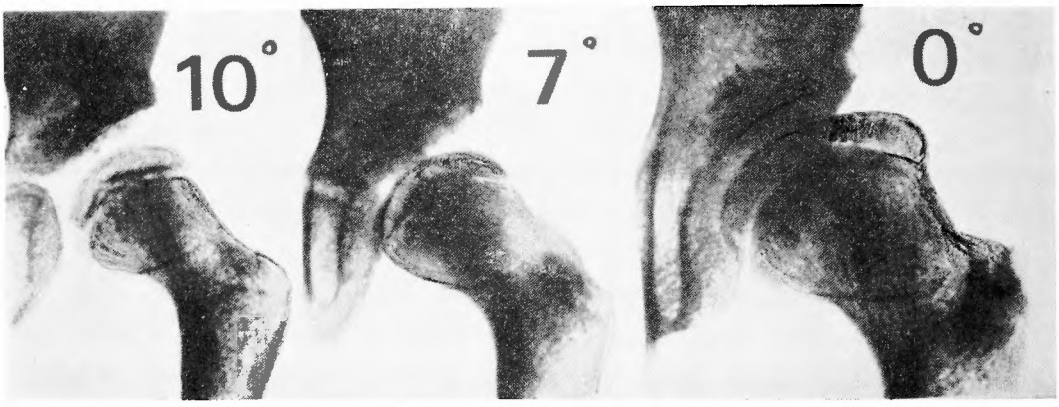
Fig. 8-A Preoperative roentgenogram
Fig. 8-B Shelf operation at three years of age, two bone shelves being inserted in the different levels.
Fig. 8-C Six months after operation
Fig. 8-D Two years after operation



8-E 8-F

Fig. 8-E Arthrogram taken at six months after operation
Fig. 8-F Seven years after operation

9-A 9-B 9-C



9-D 9-E 9-F

Fig. 9-A Preoperative roentgenogram
Fig. 9-B Shelf operation combined with derotation osteotomy at three years of age
Fig. 9-C One year after operation
Fig. 9-D Two years after operation
Fig. 9-E Four years after operation
Fig. 9 F Nine years after operation

Fig. 9 Decrease of CE-angle with age

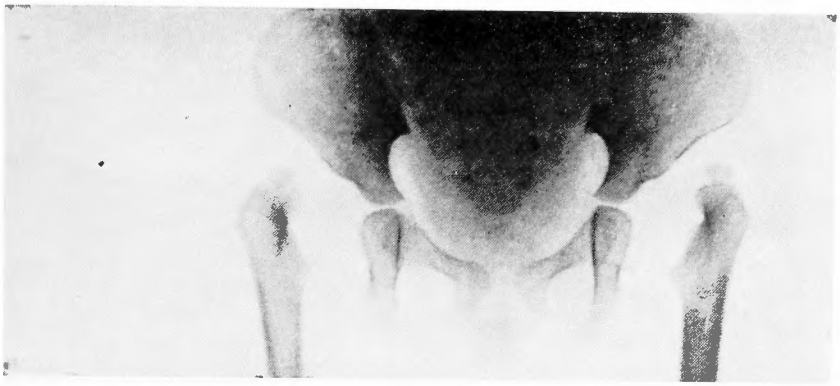


Fig. 10-A A one year and four month old girl with marked bilateral dislocation which was reduced by over head traction

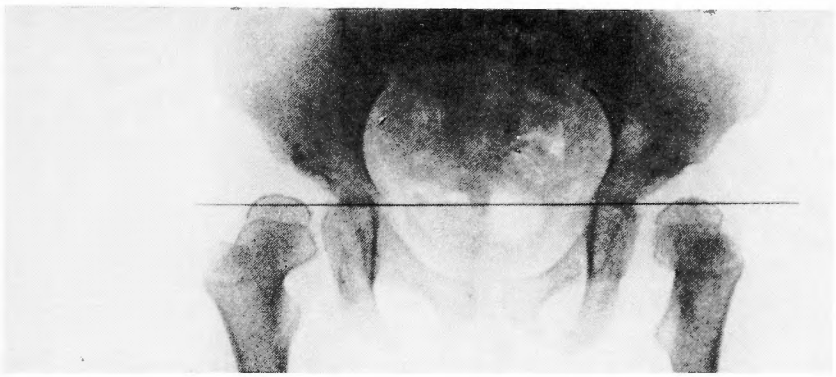


Fig. 10-B Preoperative roentgenogram at two and nine months of age, when the right hip received innominate bone osteotomy. The left hip received the same operation at five years of age.

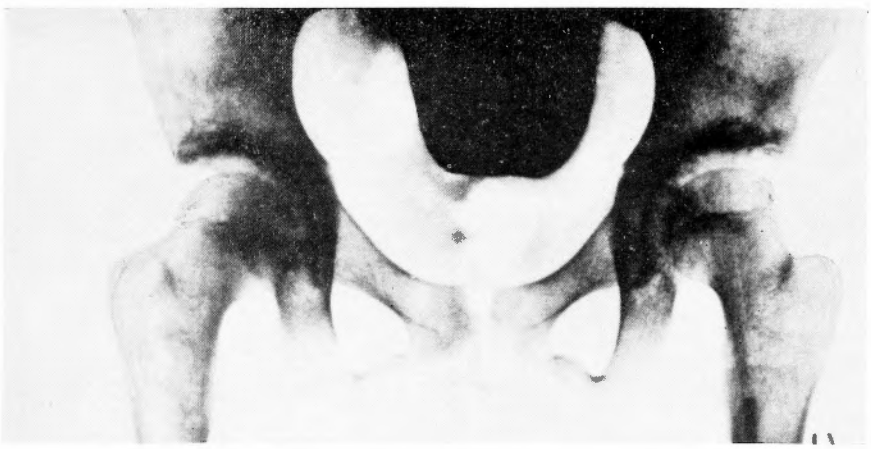


Fig. 10-C Roentgenogram at nine years of age -- satisfactory results

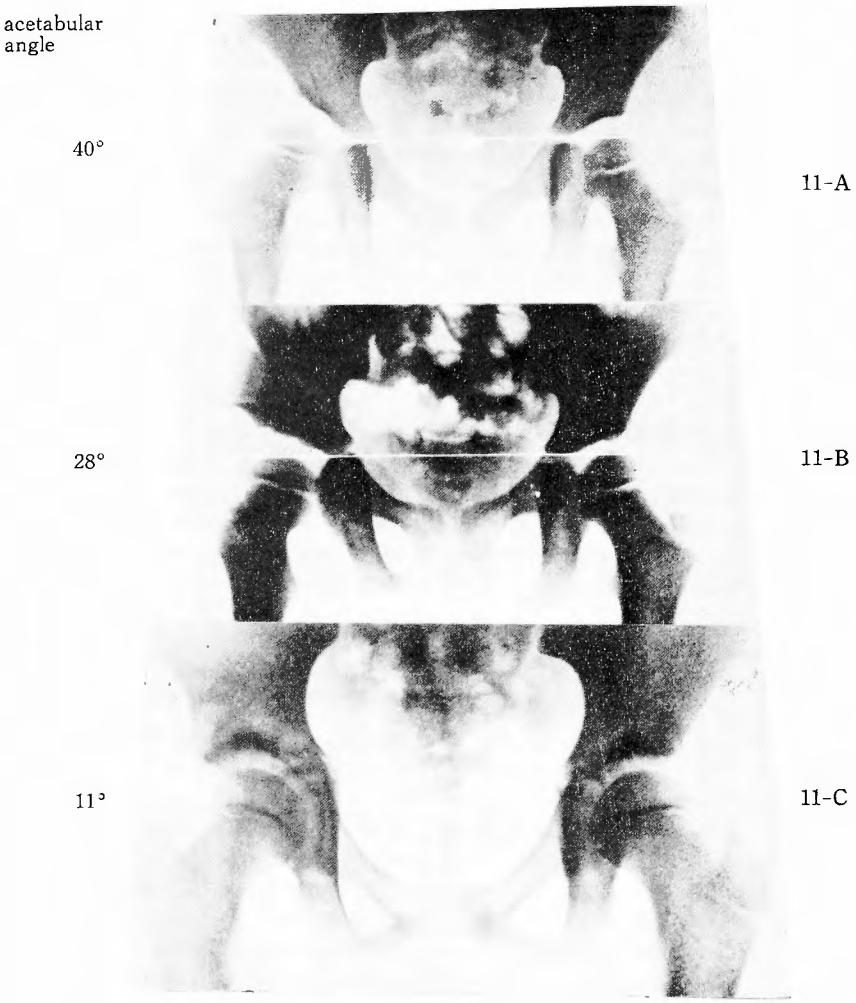


Fig. 11-A Preoperative roentgenogram
Fig. 11-B Innominate bone osteotomy at five years of age
Fig. 11-C Five years after operation ·· satisfactory results

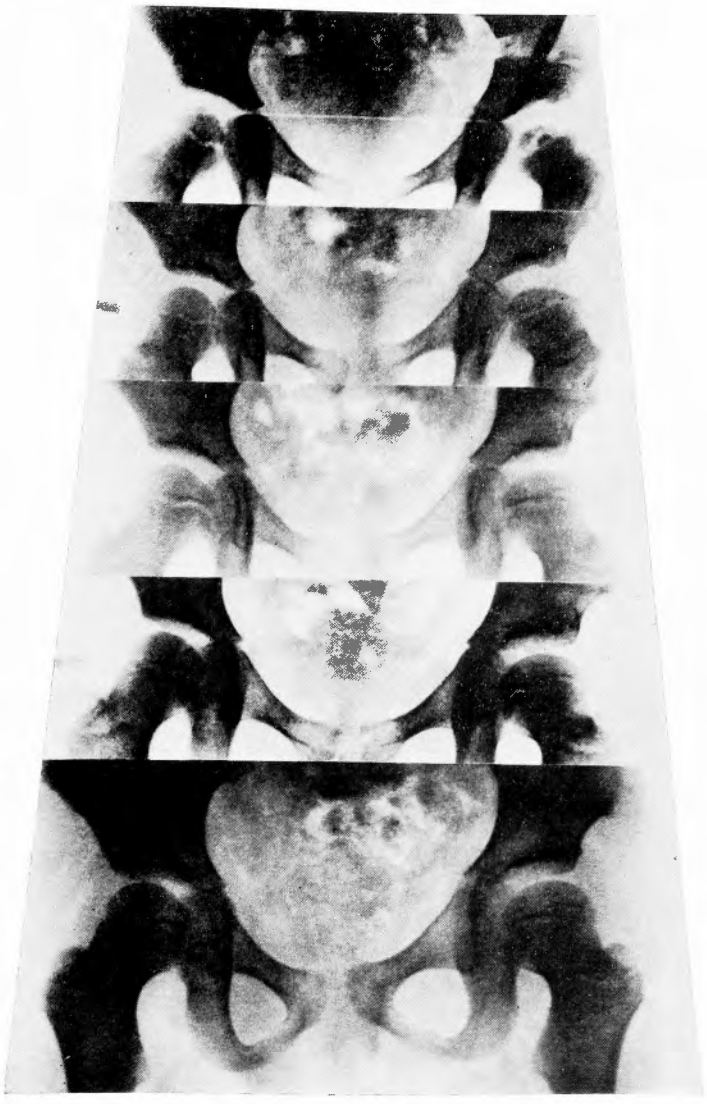


Fig. 12-A Innominate bone osteotomy at two years of age
Fig. 12-B One year after operation
Fig. 12-C Two years after operation
Fig. 12-D Three years after operation
Fig. 12-E Five years after opertion ··· satisfactory results

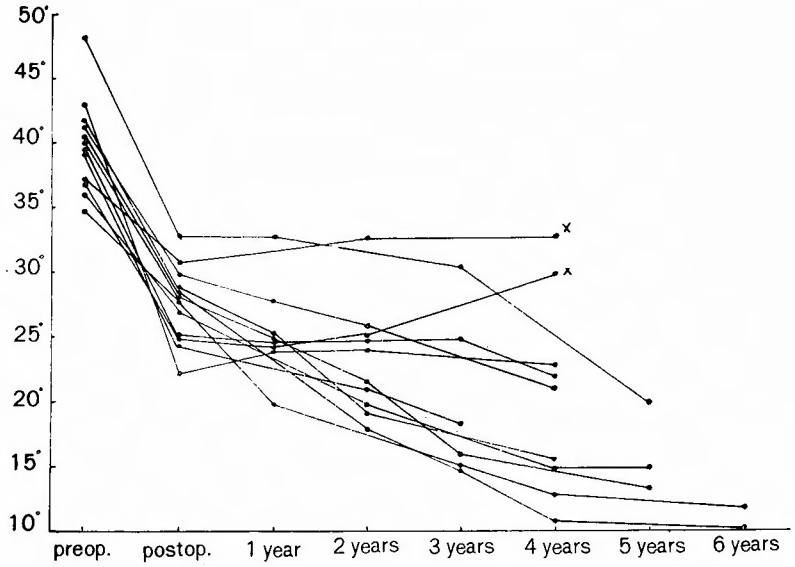


Fig. 13 Acetabular Angle (innominate bone osteotomy)

Fig. 14 Presumable growth centers of the acetabular roof (by Otte)

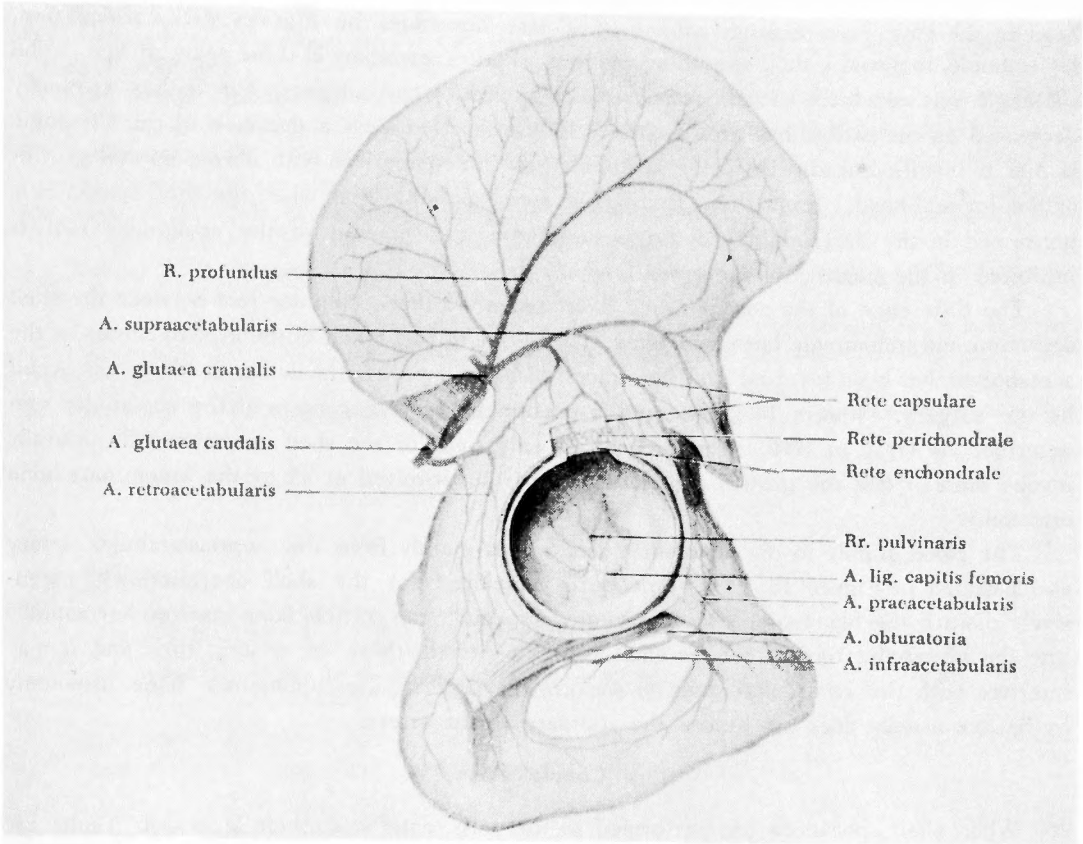


Fig. 15 Blood supply to the acetabular roof at seventh embryonal month in man (by Lanz)

Discussion

It is presumed that there may be two reasons why the long-term results of the early shelf oparation are so disappointing as compared with those of the innominate bone osteotomy. The first reasons is the difficulty in the determination of the proper level where the bone shelf should be constructed by the surgery. The case illustrated in Figures 7-A through 7-E received a shelf oparation at one year and four months of age. This is a good example to show how the bone shelf migrates upwards as the patient grows older, when the shelf was not constructed accurately in the proper level despite the immediate postoparative result seemed satisfactory on the radiogram. In the case illustrated in Figures 8-A through 8-F two bone shelves were inserted in the different levels. The upper shelf has completely been absorbed in the early postoperative stage, probably because it was located too high to function as a part of the acetabulum. The lower shelf seemed located somewhat too low to be the proper level and, as shown on the arthrogram, it seemed compressing the femoral head. At seven years after surgery, it is observed that the development of the acetabulum is very poor and osteoarthritic changes have already taken place.

The second reason of the disappointing results of the early shelf operation is the insufficient development of the acetabular roof in comparison with the development of the femoral

head in the long postoperative course. The case illustrated in Figures 9-A through 9-F, for example, recieved a shelf operation and a derotation osteotomy at three years of age. The CE angle was considered to be remarkably improved by the surgery, but it has gradually decreased as the patient has grown older. It is clear that such a decrease of the CE angle is due to insufficient growth of the acetabular roof in comparison with almost normal growth of the femoral head. From these findings it seems possible that when the shelf oparation is performed in the early childhood the postoperative development of the acetabular roof is inhibited in the majority of the cases.

The difference of the postoperative development of the acetabular roof between the shelf operation and innominate bone osteotomy may be due to how much of the growth center of the acetabulum has been involved and how much of blood supply to the center has been disturbed by the surgery. Figure 14 illustrates the presumable growth centers of the acetabular roof described by OTTE in 1969. The procedures employed for the shelf operation will naturally involve more or less the growth center, while it is not involved at all by the innominate bone osteotomy.

The blood supply to the acetabular roof comes mainly from the supraacetabular artery as illustrated in Figure 15. The procedures employed for the shelf operation will extensively disturb the blood supply to the center. Especially the cortical bone inserted horizontally into the acetabular roof as a bone shelf seems to remain there for a long time and it may interfere with the revascularization to the growth center. The innominate bone osteotomy by SALTER usually does not hinder the supraacetabular artery.

Conclusions

When shelf operations are performed in the early childhood, their long-term results are often unsatisfactory mainly due to absorption of the bone shelf and growth disturbance of the acetabulum. On the contrary, innominate bone osteotomy by SALTER seems to improve the growth and development of the acetabulum. The long-term results of the early acetabuloplasty may depend upon how much of the growth center of the acetabular roof has been involved by the surgery.

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和文抄録

幼児期における臼蓋形成術および骨盤骨切り術の臼蓋の発育に及ぼす影響について

京都大学医学部整形外科学教室 (指導：伊藤鉄夫教授)

山 室 隆 夫・岡　　正 典・ターウォン ラタナスィリ

6才未満で臼蓋形成術を受けた55症例と，骨盤骨切り術を受けた12症例について，術後5～15年に亘って臼蓋の発育に関して観察を行なった．臼蓋形成術を受けた症例では CE 角が20°以上で一応満足すべき結果を示したものは僅かに44%であった．これは形成した臼蓋の吸収と臼蓋そのものゝ発育阻害によるためと思われた．これに反して，骨盤骨切り術を行なうと術後は臼蓋の発育が促進されるように思われ，83%に満足すべき結果がみられた．この2つの術式による臼蓋の発育の違いは主として手術の際に臼蓋外縁部の成長帯やそこへの血行がいかに損傷をうけたかによるものと思われる．